Proposed Model for the Estimation of Rain Attenuation: At Ku-Band at Ota, a Tropical Location

Publisher: IEEE

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Abstract:
This study proposes a model for calculating rain attenuation on earth-space path carried out in Covenant University, Ota, Nigeria, a tropical location. The beacon signals from a geostationary satellite - ASTRA 28°E (2E/2F/2G) was monitored, recorded and analysed using a spectrum analyzer operating at frequencies of 12.245 GHz. Rain rates at the station of the antenna receivers were also logged and analysed. The rainfall rate cumulative distributions and the resultant rain attenuation are obtained and presented. The results obtained showed that the cumulative distribution of the measured rainfall rate is not in agreement with ITU-R prediction. Rainfall rate at 0.001 %, 0.01 %, 0.1 % and 1 % were fed into the existing Simple Attenuation Model (SAM) and corresponding rain attenuation were obtained. The measured rain attenuation from the beacon signal was compared with sixteen existing rain attenuation models in literature only SAM model was closed to the measured result at the location. SAM model overestimated and underestimated the rain attenuation for this location at some percentage of time. Hence, a modified SAM model is proposed using newly obtained specific attenuation coefficients. The proposed modified model is found to be close to the measured rain attenuation.

Published in: 2019 6th International Conference on Space Science and Communication (IconSpace)

Date of Conference: 28-30 July 2019
Date Added to IEEE *Xplore*: 30 December 2019
ISBN Information:
ISSN Information:
INSPEC Accession Number: 19277407
DOI: 10.1109/IconSpace.2019.8905931
Publisher: IEEE

Conference Location: Johor Bahru, Malaysia, Malaysia

I. Introduction

The troposphere is the lowest atmosphere where major weather and climatic conditions take place. This weather conditions affect propagation of electromagnetic signal which in turn has an adverse effect on communication links. Of all the weather condition, rain causes the most severe effect such as transmission of errors and reduction or outage in the received signal especially as the frequency (10 GHz and above) for propagation increases. [1]–[2] Terrestrial and satellite communication links offer a wide range of applications for

technological advancement but the impairments (e.g. attenuation) caused must be adequately mitigated. The severity of the attenuation largely depends on the rainfall rate and the frequency of propagation, although there are other factors. The prediction of rain attenuation depends on the meteorological conditions of the station of interest or locality. From research already conducted, rainfall in a temperate region differs considerably from tropical region [3]–[10]. A tropical region is observed to experience high rainfall [11]–[14]. To considerably mitigate the effect of rain attenuation in a locality, a precise rain attenuation model is important. Over the years several rain attenuation prediction models have been predicted and established to account for rain attenuation [15]. Most of these models were formulated with data measured from temperate climate. Greater percentage of these existing models do not achieve good result in the tropics due to high rainfall rate. In this research, the results of rain attenuation at 12.245 GHz frequency band satellite links is analysed. The measured experimental results obtained is compared with SAM model. The result revealed that the SAM model do not calculate the slant path rain attenuation perfectly. Consequently, from the data obtained during extensive satellite link measurement mentioned above, a systematic method is used to recommend a rain attenuation model for the study area. This suggested model attains great accurateness in the climate of the study area which can be used to calculate the cumulative distribution of rain attenuation.